

Low Frequency Acoustics

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LONG-TERM GOALS

The long-term goal is to improve understanding of very low frequency (VLF) acoustics in the deep ocean as applicable to naval warfare and coexistence with marine mammals.

OBJECTIVES

The primary objectives of the project were to: (1) initiate implementation of an acoustic data recovery capability; (2) evaluate very low frequency noise characteristics in the deep ocean; (3) encourage a cooperative interagency working relationship to investigate acoustic impact on marine mammals; and (4) declassify ocean acoustic information produced under a Navy project during the Cold War.

APPROACH

Objectives (1) and (2) were addressed cooperatively with the Applied Research Laboratories of the University of Texas (ARL:UT). Dr. David Knobles was the Principal Investigator for acoustic analysis and Jack Shooter was in charge of development of the data recovery process at ARL:UT. The interagency liaison and document declassification tasks were spearheaded by Dr. Roy Gaul.

WORK COMPLETED

Development of techniques and acquisition of equipment for data recovery set the stage for initiation of a project sponsored jointly by Code 32 in ONR and PEO/IUSS in the Naval Sea Systems Command. The article summarizing work done under a previous ONR project to evaluate VLF acoustics at a site in the northeast Pacific Ocean was completed. Under a Memorandum of Agreement (MOA) with NOAA, ONR is providing technical services that will help establish a baseline for assessment of long-term VLF acoustic trends in selected regions of the deep ocean. The document declassification effort is ongoing.

RESULTS

Acoustic Data Recovery

The cooperative effort with ARL:UT has expanded the capability for acoustic data recovery from magnetic tapes recorded in self-contained taut-wire buoy systems. A customized tape cleaning system,

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sponsored by NOAA, was added to the ARL inventory. Improved procedures for heat treatment of magnetic tapes and upgraded A/D processing techniques have been implemented. These refinements enabled further development to meet the need for subsequent recovery of data from sites in the Philippine Sea that is ongoing under separate ONR contracts. These projects have demonstrated that data recorded on magnetic tape two decades ago can be recovered with accuracy equivalent to measurements using modern technology. Current data processing and storage capabilities allow utility for analysis that could not be achieved when the data were acquired. The fully digitized data sets are available to third parties both within and outside of the Navy.

Shipping and Wind Dependence

Analysis by Gaul and Knobles (paper approved for publication in the JOE/IEEE) indicates that noise generated by local wind, at speeds of at least 20 knots, falls off sharply at frequencies below about 400 Hz. Background sound pressure level in deep water (near the seafloor at 800 meters below critical depth) at 200 Hz was measured as low as 40 dB re one micro-Pascal. Instrumentation limitations have precluded reliable measurements of the deep water ambient noise floor at lower frequencies. At low wind speeds and in the absence of nearby shipping, extrapolation of results from our analysis indicates that ambient noise levels below 40 dB could extend to frequencies as low as 10 Hz.

VLF Acoustic Baselines

Informal liaison with NOAA(NMFS) and other parties has dealt with ocean acoustics related to issues stimulated by the Marine Mammal Protection Act. A focal point has been long term trends of ambient noise in the VLF band influenced by shipping. The concept of separating the ship-driven noise field into three parts (local, near-field, and remote) has been emphasized. The local condition exists when one or more ships dominate the noise spectrum and cause levels much higher than the statistical background. Near-field shipping generates noise that selectively adds to the background spectrum with moderate and intermittent increases in level. The aggregation of remote shipping produces the acoustic noise background that has small statistical variations in the range of hours to days. NOAA is sponsoring a continuing project under its MOA with ONR to codify and evaluate long-term trends of VLF ambient noise in selected ocean regions.

Document Declassification

By letter dated 20 January 2006, CNO (N772A) authorized declassification and unlimited distribution of all CONFIDENTIAL documents issued prior to 1982 that are related to the Long Range Acoustic Propagation Project. An additional request for release of SECRET documents is under consideration. A selection of more than 100 identified documents has been provided for review to establish a basis for total release. Liaison is continuing with the expectation of further action by N772A before the end of this calendar year.

IMPACT/APPLICATIONS

The VLF segment of the acoustic spectrum has not been exploited for purposes of undersea surveillance. There may be significant potential for some critical applications to modern warfare. The VLF spectrum also holds the prospect for use by the Navy with minimal impact on the marine mammal population.

PUBLICATIONS

Gaul, R. D., D. P. Knobles, J. A. Shooter, and A. F. Wittenborn, "Ambient Noise Analysis of Deep Ocean Measurements in the Northeast Pacific," IEEE J. Oceanic Engineering, [in press].